National Aeronautics and
Space Administration

NASA EXPLORES
Modular Supercomputing

The NASA Advanced Supercomputing (NAS) Division's innovative modular approach to expanding NASA's high-end critical computing capabilities reflects the agency's continued leadership in the high performance computing community. Two sites with modular structures built at NASA's Ames Research Center in Silicon Valley house a pair of peta-scale supercomputing systems and their infrastructure to help solve the agency's most challenging problems in an environmentally conscious way that also provides flexibility, power efficiency, and cost savings.

NASA ADVANCED SUPERCOMPUTING (NAS) DIVISION

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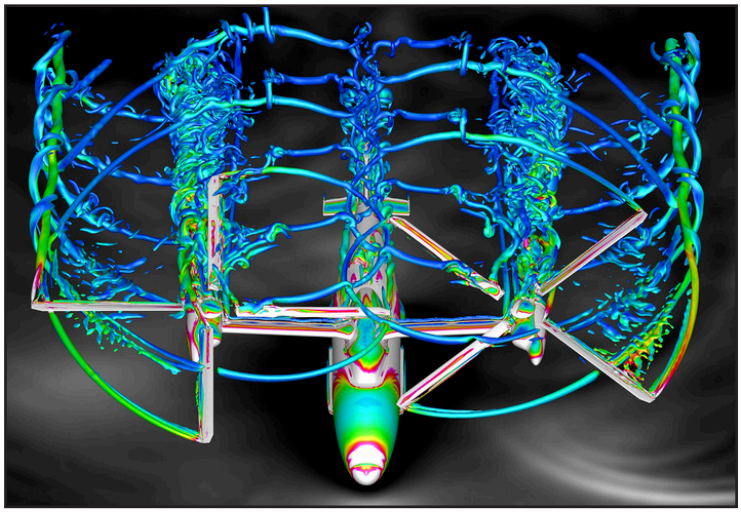
Working with industry partners, the NASA Advanced Supercomputing (NAS) Division designed, built, and installed the first proof-of-concept Modular Supercomputing Facility, housing the Electra supercomputer, in 2016. This prototype module uses a combination of outdoor air and fan technology to remove the heat generated by the system, taking advantage of the San Francisco Bay Area's temperate weather. With this cooling technology, the system and module consume less than 10% of the energy needed to cool the same amount of resources on NAS's traditional computer floor. The facility was expanded with a second module, populated with HPE E-Cells in 2017 and 2018. This second module combines the outdoor air cooling technology with a circulating water system, which uses two adiabatic coolers on its roof to send chilled water down to the computer racks.

The Electra supercomputer is a petascale proof-of-concept system for the agency's modular computing technology, which saves significant amounts of water and power annually. Marco Librero, NASA Ames



Visualization of NASA's side-by-side concept rotorcraft, showing the complex interactions between the intermeshing rotors. Simulations were carried out on the Electra supercomputer at the NASA Advanced Supercomputing facility. Patricia Ventura Diaz, Tim Sandstrom, NASA Ames

The success of the prototype modular facility led the NAS Division to build the infrastructure to support deployment of NASA's next major computer system on a one-acre site. The initial module and racks of the new Aitken system were installed in summer 2019, with the first expansion in 2020 more than doubling the system's computing power. The site where Aitken is installed will be able to hold 16 modules for computing and data storage. With NASA's ever-increasing demand for more computing resources, modular supercomputing significantly reduces the annual water and energy consumption needed to maintain these systems, while also allowing for the flexibility to add new resources with minimal impact to users. The resulting cost savings translate to purchasing power for additional capabilities to deliver world-class supercomputing for the more than 1,500 users across the U.S. who rely on NASA high-end computing to make new scientific discoveries and expand human knowledge.

Aitken Architecture Overview

- 4 HPE E-Cells with Intel Xeon Cascade Lake processors; 8 HPE Apollo 9000 racks with AMD Rome processors
- 2,176 nodes, 177,152 cores, and 740 TB of memory
- 8.41 petaflops theoretical peak performance
- 6.39 petaflops sustained performance (November 2020)

Aitken Module Efficiency Stats

- Power Usage Effectiveness (PUE) ratio: 1.05
- As compared to the same amount of computing resources in the main NAS building, the module housing Aitken annually:
  - Consumes 16% of the energy needed for cooling, saving over $100K or 1.4 million kilowatt-hours
  - Reduces water usage for cooling by 91%, saving over one million gallons

Electra Architecture Overview

- 16 SGI D-Racks with Intel Xeon Broadwell processors; 8 HPE E-Cells with Intel Xeon Skylake processors
- 3,456 nodes, 124,416 cores, and 589 TB of memory
- 8.32 petaflops theoretical peak performance
- 5.44 petaflops sustained performance (Nov 2020)

Electra Module Efficiency Stats

- Power Usage Effectiveness (PUE) ratio: 1.04
- As compared to the same amount of computing resources in the main NAS building, the module housing Electra annually:
  - Consumes 16% of the energy needed for cooling, saving over $250K or 3.3 million kilowatt-hours
  - Reduces water usage for cooling by 77%, saving over three million gallons